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Fig. 7. Raisin Tree
Hovenia dulcis Thunb.

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THE ASSOCIATES OF THE MORRIS ARBORETUM

The ASSOCIATES, through whose interest and generosity this *Bulletin* and certain other undertakings of the Arboretum are made possible, is an informal group of individuals interested in encouraging and furthering the educational and research endeavors of the Morris Arboretum. Further information concerning this organization will be sent on request.

THE RAISIN TREE

Illustrated on page 13 are flowers of the Japanese Raisin Tree, *Hovenia dulcis,* an infrequently described ornamental which is unusual and apparently still a rarity, even in botanical collections.

Although the Raisin Tree was introduced as early as 1820 from Japan it is in reality a native of central China which, through cultivation, was early carried throughout China and India as well as to Japan and Korea. The name Hovenia is in honor of David ten Hoven, 1724-87, senator of Amsterdam.

Hovenia dulcis is akin to Ceanothus and the Buckthorns, being a member of the family Rhamnaceae. It is grown principally for its handsome, glossy, green, broad, and long-petioled leaves. The flowers are yellowish green and, though small, are produced abundantly in axillary and terminal clusters in late June. They have a peculiar, pungent odor which seems attractive to many kinds of insects. Fruits, which are about the size of a pea, are borne partially embedded in fleshy and swollen flower stalks. These contorted

(*Continued on page 20*)

FIG. 8. *Hovenia dulcis* at Morris Arboretum

EASTERN ASIATIC PLANTS IN EASTERN AMERICAN GARDENS[1]

John M. Fogg, Jr.

Even the most casual visitor to the Morris Arboretum cannot fail to be impressed by the overwhelming preponderance of trees and shrubs growing there which are native to southeastern Asia. Although he may not be able to recognize or identify these species on sight, he need only glance at the labels to learn that many plants are indigenous to China, Manchuria, Korea, Japan, or some other portion of the Orient. Indeed, so large is the number of these exotics that at times it necessitates a conscious effort to realize that one is still in eastern North America.

Scattered throughout the broad acreage of the Arboretum are splendid specimens of such plants as the Ginkgo or Maidenhair Tree (*Ginkgo biloba*), Golden Larch (*Pseudolarix amabilis*), Umbrella Pine (*Sciadopitys verticillata*), Chinese Elm (*Ulmus parvifolia*), Siberian Elm (*U. pumila*), Katsura Tree (*Cercidiphyllum japonicum*), False Spiraea (*Sorbaria sorbifolia*), Pearl Bush (*Exochorda racemosa*), Pagoda Tree *Sophora japonica*), "Japanese Quince" (*Chaenomeles lagenaria*), Hardy Orange (*Poncirus trifoliata*), Cork Trees (*Phellodendron* spp.), Cedrela (*Cedrela sinensis*), Varnish Tree (*Koelreuteria paniculata*), Raisin Tree (*Hovenia dulcis*) and Beauty Bush (*Kolkwitzia amabilis*). All of these are native to southeastern Asia. In addition to the above, the visitor will observe that certain genera with which he may be familiar in our native flora are represented by large numbers of oriental species. This is particularly true of Magnolia, Berberis, Hamamelis, Benzoin, Hydrangea, Philadelphus, Spiraea, Malus, Prunus, Wisteria, Gordonia, Stewartia, Cornus, Rhododendron, Callicarpa, Lonicera and Viburnum. All of these are genera which have their centers of origin in the Middle Atlantic States and in southeastern Asia, with usually an appreciably larger number of species native to the latter area. Certain other genera such as Caragana, Enkianthus and Weigela occur solely in Asia and are known to us only through cultivation.

The situation just described is not in any sense peculiar to the Morris Arboretum, but may be duplicated in practically every other large collection of living trees and shrubs in the eastern United States. In fact, many collections of woody plants in this part of the world are richer in oriental species than in those native to eastern North America.

To understand why it is that the flora from a region ten thousand miles distant should be so well represented in our gardens, parks and arboreta, we must turn to the evidence furnished us by the geologist and the paleobotanist, or student of fossil plants. It is necessary to project our minds backward millions of years into earth history and inquire briefly into the long sequence of events which has produced the existing vegetational pattern on the surface of the earth. Since the story is a lengthy and involved one, it will be well to confine ourselves to that portion of it which concerns the northern hemisphere.

Of all groups of living plants the most important and most numerous are the seed plants, with something like one hundred and fifty thousand species, a number far in excess of the combined total of all other types of plants. The seed plants comprise two subdivisions: the Gymnosperms and the Angiosperms. To the Gymnosperms, or naked-seed plants, belong the Cycad, the Ginkgo and the Conifers—including such familiar "needle-bearing" softwood trees as Yew, Pine, Larch, Cedar, Fir, Hemlock, Cypress and Juniper. In the Angiosperms or true flowering plants, the seeds are enclosed in and protected by the matured ovary or fruit. To this subdivision, which is by far the larger, belong not only all of the deciduous, hardwood, broad-leaved trees, but all of our familiar shrubs and herbaceous plants, including grasses, sedges and rushes.

Of these two subdivisions the former is much more primitive and more ancient. Indeed, the Gymnosperm line extends back some two hundred million years to the end of that great era known to the geologists as Paleozoic. Here, during the period when much of our coal was being formed, there flourished the ancestors of our present-day Cycad, Ginkgo, Pine, Fir, Larch, Spruce, Juniper, Cypress, as well as many other Gymnosperms which have long since become extinct. Further-

[1] Condensation of a talk delivered in the series of outdoor tours at the Arboretum on Saturday, May 30, 1942.

more, there is abundant evidence to indicate that for long stretches of millions of years these ancient Gymnosperms were widely distributed over the earth's surface, growing in regions north of the Arctic Circle where today it would be impossible for them to exist. The explanation of this broad distribution lies in the fact that the climate toward the poles was at one time much milder than it is today.

The close of Paleozoic was marked by the uplift of the Appalachian Mountains, which at the time of their elevation were considerably higher than they are today. Many of the early Gymnosperms became extinct at this time and we witness here the first great disruption in the continuity of our modern floras.

The Angiosperms, or flowering plants, are of much more recent origin than the Gymnosperms. Their beginnings may be traced back with certainty to the period known to geologists as Cretaceous. By the end of this period, which terminated the great Age of Reptiles, the Angiosperm flora had become well established. Late Cretaceous deposits contain fossils of many of our modern forest types such as Willows, Poplars, Oaks, Chestnuts, Beeches, Buttonwoods, Sassafras, Magnolia, Persimmon, and many others. Since this period came to its close about sixty million years ago, it is clear that, although the Angiosperms are considerably younger than the Gymnosperms, many of our present-day genera still possess a venerable ancestry.

As was true in the case of the older Gymnosperms, or conifers, an ever increasing body of evidence demonstrates that these early flowering plants enjoyed a much wider distribution than is the case today. Such trees as Magnolia, Sassafras, Persimmon and Tupelo not only occurred in every major land mass of the northern hemisphere but even grew in such now inhospitable regions as Alaska, Greenland, Iceland, Spitzbergen, Novaya Zemlya, Franz Joseph Land and northeastern Siberia. This is again indicative of the fact that during much of Tertiary time (the period of about sixty million years which followed the Cretaceous) the world climate was much more equitable than it is now. Indeed, the present distribution into climatic zones, such as Arctic, Temperate and Torrid, must be regarded as one which is very untypical of the long history of the earth. The normal situation, and one which has persisted throughout the great body of geological time, is for temperatures to be warmer near the poles and cooler near the equator than is true now. The reasons for this are rather complex but may be stated briefly as being concerned with mountain uplift and land barriers. There are at present many high mountain ridges in existence, but this has not always been so; and during long periods of millions of years each, when the average elevation of the continents was nearer sea level than it is now, there was much freer circulation of both air and water currents, resulting in the more uniform world climate mentioned above. This uniformity of climate was naturally reflected in a more even distribution of plants and animals.

In contrast to the wide-spread distribution of plants which characterized most of Tertiary time, we find today that the same genera which were formerly ubiquitous are restricted to smaller areas or centers of distribution which may be separated from each other by several thousand miles. Obviously something has happened to disrupt the former broad ranges of these genera, and it becomes pertinent to ask what these factors were. When we inquire what influences have been at work which would tend to alter the vegetation during the last sixty million years, we find that they fall into four categories: submergence, mountain uplift, volcanic activity, glaciation. Let us examine each of these briefly.

As has been said before, the Angiosperms, or true flowering plants, first became dominant toward the close of Cretaceous time, at which period they seem to have been widely distributed over the surface of the earth. Now Cretaceous time, among other things, was a period of lowering, or down-warping, of the continents, resulting in flooding by the oceans and the creation of great inland seas. Such a sea extended from the Gulf of Mexico to the Arctic Ocean, separating North America into two great halves or islands. As may well be imagined, this inundation completely destroyed the terrestrial vegetation which had formerly occupied the area now flooded. At the same time similar inundations were affecting parts of other continents, notably Europe. The Mediterranean occupied an area probably three times as great as that of its present basin and much of the original Angiosperm flora of Europe was destroyed as a result. Even after the Cretaceous seas were " tipped off " by the uplift of the con-

tinent much of the Atlantic Coastal Plain and the present Gulf States remained under the waters of the Atlantic Ocean and continued to be submerged for many millions of years during Tertiary.

In all cases where an area has been submerged for a long interval and is subsequently exposed, its surface is composed of sediments which were deposited while it was under water. These soils are therefore of more recent origin than the underlying formations, and the region is then repopulated either by newly evolving forms of plant life or by the more aggressive and pioneering species from some nearby survival area. Hence, we conclude that the flora of Mediterranean Europe or of the Atlantic coastal plain or of our own midwestern area is more modern than that of regions which were not submerged.

Mountain uplift in itself probably exerts no serious influence upon plant life. This results from the fact that mountain building takes place very slowly and may require thousands, if not hundreds of thousands, of years for its completion. We might be living on the future crest of a newly forming mountain today and be completely unaware of it. What is important in mountain uplift is the subsequent change of climate which it induces. When, for example, a mountain axis, such as that of the Rocky Mountains, is at right angles to the direction of the prevailing westerly winds, a marked difference in temperature and rainfall relations ensues. Moisture-laden winds blowing in from the Pacific strike against such a ridge and deposit their rainfall. This results in the region east of the mountains becoming arid. Therefore, an area which formerly possessed a rather uniform climate may, following uplift, be differentiated into rain forest on one side and desert on the other. This is but a crude and somewhat over-simplified example of the type of influence which has altered the vegetation in many parts of the world as a result of mountain building.

It is highly significant that since the beginning of Tertiary time, some sixty million years ago, eastern North America has not undergone any pronounced uplift of the type which much earlier produced the Appalachian Mountains. In marked contrast to this is the situation in western North America, where, since the advent of the Angiosperms, there have been two major episodes of uplift. The first of these, occurring as the Laramide Uplift at the end of Cretaceous, produced the Rocky Mountain axis. Then, millions of years later, toward the close of Tertiary, occurred the Cascade Uplift, which elevated the Pacific Coast ranges, including the Sierra Nevadas. These last-named ridges are therefore the youngest of all mountains on this continent.

Thus it will be seen that the climate of central and western North America has been profoundly altered at least twice, as a result of uplift, with corresponding effects on the distribution of plant-life.

Had we time to consider the events which took place in other continents we would see again the profound influences of uplift in changing the previous climate. One example that may be mentioned is the Alps of southern Europe which are mountains of a very recent origin, the uplift of which exerted profound effects upon the plant life of that continent. It is also worth noting in passing that whereas the mountain systems of North America have in general a north to south trend, the prominent ranges of western and central Europe extend in an east to west direction.

The only other considerable area in the northern hemisphere which has not undergone uplift since the appearance of our modern flora is southeastern Asia. Here, although there are mountains they are of much more ancient origin, corresponding to the Appalachians in age and in the degree to which they have been lowered, rounded and dissected by erosion.

When we say that volcanic activity has influenced the distribution of plant-life we do not refer entirely to the more spectacular type illustrated by such volcanoes as Vesuvius or Etna, although many such occurred in previous times. We mean rather the slow outpouring of hot volcanic rock which has so often occurred in geologic history when cracks or fissures have developed in the earth's crust. For instance, during Tertiary time many thousands of square miles in western North America were covered by the outpourings of such material, resulting in total destruction of all terrestrial life. Some of these deposits were very thick and may be readily seen in the western states today (notably Washington, Oregon, Idaho, Nevada, New Mexico and Arizona) where they have weathered to form dark colored soils which are often very fertile in those areas where rainfall is sufficient. Similar out-

pourings in other continents exerted corresponding influence upon living things.

Of all of the factors which have tended to wipe out existing vegetation the most recent, and in a sense the most spectacular, has been the formation of great continental ice sheets or glaciers. This is not to say that glaciation has been confined only to recent geological times. On the contrary, there is evidence that the close of each major geologic interval was attended by glaciation. However, most of these earlier accumulations of ice took place before the date of evolution of our modern flora and it is still true that for us the most significant of all the great glacial epochs is that which was inaugurated about a million years ago. This most recent manifestation falls within the period known to the geologist as Pleistocene.

Originating in three, or possibly four, centers in northern North America, the ice moved southward over all of Canada, New England, New York and in our area reached its southern limit in extreme northeastern Pennsylvania. It also covered the northern half of Ohio and Indiana and pushed southward near the junction of the Missouri and Mississippi Rivers. Obviously, this tremendous field of ice acted effectively to destroy the vegetation not only in the area upon which it lay but probably also for some miles beyond the actual ice front. Evidence indicates that Pleistocene glaciation was not a single phenomenon but that there were several advances of the ice separated by warmer interglacial periods during which the vegetation was able to regain much of the area from which it had been excluded. In Europe, glaciation centered mostly about Scandinavia and the Baltic area and was not so extensive as in North America. Much of eastern Europe was unglaciated and strangely enough Asia was visited only by local glaciers. This resulted from the fact that one of the factors necessary for continental glaciation is abundant precipitation and much of Siberia was, and is today, rather arid. Even portions of Alaska were not covered by ice fields nor were the islands of the Arctic Archipelago. Again, this was due to lack of precipitation.

The last advance of the Pleistocene ice, known to students as the " Wisconsin Phase," apparently began to disappear about thirty thousand years ago. Shrinking back toward its centers of origin, the ice slowly left uncovered New York, New England and southern Canada. At the same time it was shrinking southward from the Arctic Ocean and exposing vast areas in Labrador and northern Canada. The vegetation of most of Canada and all of New England has therefore had to reestablish itself only within these last few thousand years. Man himself probably did not reach the North American continent by way of Bering Straits until some ten thousand years ago, at which time the Wisconsin ice had melted sufficiently to permit his migrations.

Looking backward now over this sequence of events we see that most large areas of the northern hemisphere have been subjected to at least one, if not more, of these destroying influences. Indeed, there are only two major regions which have in any sense escaped and have succeeded in retaining the vegetation with which they started at the beginning of Tertiary time. Those are the Appalachian Plateau (and the smaller Ozark Plateau), south of the southernmost line of glacial advance, and southeastern Asia. All other portions of the northern hemisphere have either been submerged by continental seas or have had their climate profoundly altered as a result of mountain-forming, or have suffered from the encroachments of ice sheets of great thickness.

Therefore, it is no mere coincidence that there should be such a strong resemblance between the flora of the Appalachian Plateau and southeastern Asia. The similarity in the trees, shrubs and herbs of these two regions is not merely a chance occurrence but results from the long sequence of events just indicated. The story in these two regions is one of continuity, survival and persistence contrasted with the discontinuity, destruction and revegetation which characterize most other parts of the northern temperate zone.

In the Middle Atlantic States and in China we have reason to believe that many of the plants alive today are the offspring of a very ancient line extending far back into geologic time. Such a genus as Liriodendron, for instance, is known to have occurred in all parts of North America as far north as Alaska, in western Europe as well as across Siberia. This was during Tertiary time. Today Liriodendron is represented by a single species in the Middle Atlantic States, *L. tulipifera*, the Tulip Tree, and by a closely related species in China. In all other areas it has become extinct

due to one or more of the destructive factors described earlier. Indeed, so similar are the American and Chinese Tulip Trees that it requires considerable discrimination to separate them. Many botanists consider them one and the same species. It is rather stirring to realize that the plants of this species which tower over our heads in the forests today have descended directly from ancestors which were once world-wide but which have survived only in those two parts of the world where conditions have been uniform.

It is actually true that the botanist familiar with the plants of the Appalachian Plateau will feel more at home when visiting southeastern Asia than in any other portions of the world. There he will find not only many of the common forest trees such as Tulip Tree, Magnolia, Sassafras, Persimmon and others, but such shrubby forms as Witchhazels, Dogwoods, Rhododendrons, Barberries and scores of others.

Even the herbaceous flora, which is probably less ancient than the woody one, displays many affinities. For example, the Skunk Cabbage, which was doubtless wide-spread during Tertiary, is today confined to the woodland swamps of Appalachian America and southeastern Asia. In fact, the Chinese species is indistinguishable from our own. To some it may seem that seeds of this plant might, in recent times, have been transported from one area to the other, but there is no evidence to indicate that this is so. Surely the heavy seeds of this species could not be borne by winds, birds, water currents or any other agencies which usually serve to disseminate plants. Even if this were possible we should expect to find colonies of Skunk Cabbage in western America or some other part of the world where it might have established itself. The actual explanation, as in the case of the trees, is that Skunk Cabbage has persisted in these two widely remote regions while undergoing extermination in other areas which it once occupied. Many other herbaceous genera (such as Hydrastis, Trautvetteria, Diphylleia, Jeffersonia, Podophyllum, Panax and Phryma) have had a comparable history and are today found only in eastern Asia and eastern America.

It should now be apparent that because of the similarity in geologic history southeastern Asia and Appalachian America possess similar soils and comparable climates. This will explain why oriental plants are so highly successful when transported to our region. The reverse is equally true. It is a conspicuous fact that China is still the most productive source of introductions for eastern American use. The explorations of Fortune, Wilson, Rock and many another plant hunter have added hundreds of Chinese species to our parks and gardens, and there are doubtless many more awaiting discovery and introduction.

It must not be inferred from the above discussion that plants from other parts of the world cannot be made to grow here. Let us briefly consider two other major areas. As has been pointed out, the story of events in Europe is one of wholesale destruction and subsequent replacement rather than survival. That part of the original flowering-plant flora of Europe which was not disturbed by inundation suffered heavily from the twin influences of mountain building and climatic change. Furthermore, glaciation in Europe, although less extensive than in North America, took its large toll of the vegetation. This was due to the fact that the ice advanced from the north and that the mountain ranges, trending, as has been said, from east to west, served as a barrier to prevent plants from migrating before the advancing ice front. This was very different from the situation existing in eastern North America where plants had the entire Appalachian Plateau in which to take refuge as glaciation moved southward.

Despite these destructive factors which so seriously modified the primal vegetation of Europe, certain restricted areas managed to escape and succeeded in retaining much of their early flora. This is particularly true of portions of the Caucasus, of the Balkan peninsula and a few still smaller survival areas in extreme southwestern Europe. As would be expected, the plants of these regions possess an antiquity comparable to our Appalachian flora and, by the same token, may be successfully grown in our portion of the world. Many other European species, however, may be grown only with difficulty, if at all, in the Middle Atlantic States. They come from a region where the soils are of modern origin and where the climate differs from our own. Many of them may be cultivated on the more youthful soils of our Pacific states, where, too, they enjoy a climate (mild winters and cool summers) more like that of Europe than is our Eastern one. Climate, it must always be remembered, is as much a product of geological events as are soils.

That portion of North America lying west of the hundredth meridian has undergone a geologic history similar to that of much of Europe. As already shown, it has suffered from submergence, uplift, climatic shift, volcanic outflow and, the northern portion of it, from glaciation, so that we find there modern and highly specialized plant families (such as the Mallows, the Spurges, the Mints, the Figworts and the Composites) adapted to soils of comparatively recent origin. As would be expected, we encounter in general the same difficulties in growing plants from that part of the country that we do with European species, and for the same reasons. Only a few of the spectacular forms characteristic of our western states can be made to succeed in eastern gardens.

Perhaps this very casual survey of vegetation through the ages will raise more questions than it answers. The subject is a complex one and many other factors than those which have been enumerated must be taken into consideration. Enough has probably been said, however, to suggest that an understanding of past events is helpful in interpreting many of the problems which face the botanist and the horticulturist. If a few of these points are held in mind, it should increase the interest of the visitor who wanders through a large collection of plants and reads the labels. As with human history, so here a knowledge of what has gone before will enhance the appreciation and emphasize the significance of what we see today.

LECTURE TOURS AT THE ARBORETUM

Attention is again drawn to "discussion" tours of the 1942 season. The remaining two of this series will be held as follows:

September 26, 2:30 P. M.

POISONOUS PLANTS OF FARM AND GARDEN

Leader: D. WALTER STECKBECK, Associate Professor of Botany, University of Pennsylvania.

Dr. Steckbeck has studied poisonous plants in various regions of the United States and is in charge of the work in Veterinary Botany at the University of Pennsylvania. Special attention will be given to poisonous and near poisonous plants of the Pennsylvania countryside with some reference to exotics and to plants yielding drugs.

October 10, 2:30 P. M.

MAN AND NUT TREES

Leader: J. RUSSELL SMITH, Swarthmore, Pa. Emeritus Professor of Economic Geography, Columbia University.

No one has contributed more to the field of Economic Geography than Dr. J. Russell Smith. He is president of the Association of American Geographers as well as author of various texts and articles in this field, including a book, *Tree Crops, a Permanent Agriculture.* A world traveller, Dr. Smith has studied tree crops and their potentialities for permanent land improvement in many climates besides our own. He will have food for thought as well as first hand and practical information on nut varieties.

Both tours, occurring on Saturday afternoons, will commence at 2:30 P. M. at the Administration Building. They are free to everyone.

THE RAISIN TREE (Continued)

stalks are sweet to the taste and are regarded as highly palatable by oriental peoples. Hovenia has never fruited at the Morris Arboretum.

The tree illustrated in fig. 8 has a height of 31 feet and a spread of 35. It was considerably larger than this before suffering severe—almost devastating—injury during the winter of 1933-'34. It is a tree capable, however, of sending strong young shoots from the main trunk and in eight years this plant has recovered its shape and size in a remarkably successful manner. In normal seasons the Raisin Tree is perfectly hardy and a highly desirable ornamental for this region.

HENRY T. SKINNER